

WHAT IS CLAIMED IS:

- 1        1.        A method for managing files in a file system, comprising:  
2        receiving data for a file;  
3        storing the data for the file in a plurality of segments;  
4        generating an index associated with the file indicating how the file data maps to  
5        the segments;  
6        receiving an Input/Output request with respect to an address in the file;  
7        using the index for the file to determine the segment including data at the  
8        requested address in the file; and  
9        accessing the determined segment including the data at the requested address.
- 1        2.        The method of claim 1, wherein data is stored in the segments by:  
2        writing the received file data to one segment; and  
3        writing further received data for the file to subsequent segments if the last  
4        segment to which the received data was written has no more available space.
- 1        3.        The method of claim 1, wherein each segment has a fixed byte length,  
2        wherein the index provides a segment order indicating an order in which file data is  
3        written to the segments, and wherein the index for the file is used to determine the  
4        segment including data at the requested address in the file by:  
5        determining an offset into the file including the data at the requested address; and  
6        determining an integer quotient value resulting from the offset into the file divided  
7        by the fixed byte length, wherein the segment including the data at the requested address  
8        is the segment at the integer quotient value in the segment order.
- 1        4.        The method of claim 3, further comprising:  
2        receiving user input indicating the fixed byte length of each segment.

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1           5.     The method of claim 1, further comprising:  
2           providing a segment size that is at least greater than a byte size of a largest section  
3     within the file; and  
4           writing each file section to one segment.

1           6.     The method of claim 1, further comprising:  
2           storing the segments in a primary storage;  
3           copying at least one of the segments in the primary storage onto a secondary  
4     storage; and  
5           releasing at least one of the segments copied to the secondary storage, wherein  
6     space used by the released segment in the primary storage is available for use.

1           7.     The method of claim 6, wherein as a result of releasing one or more  
2     segments, different segments for one file are capable of being stored in the primary  
3     storage and the secondary storage.

1           8.     The method of claim 6, wherein accessing the determined segment  
2     including the requested address further comprises:  
3           determining whether the determined segment is available in the primary storage;  
4     and  
5           copying the determined segment from the secondary storage to the primary storage  
6     if the determined segment is not available in the primary storage.

1           9.     The method of claim 6, wherein releasing the segment comprises:  
2           storing a partial version of the released segment including less than all data in the  
3     segment, wherein the segment data not in the partial version is stored in the secondary  
4     storage, wherein the partial version remains on the primary storage after the segment is  
5     released.

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1 10. The method of claim 9, wherein the partial version of the determined  
2 segment is on the primary storage and wherein accessing the determined segment  
3 including the requested address further comprises:  
4 accessing the partial version of the determined segment on the primary storage to  
5 access the data therein;  
6 reaching the end of the partial version when accessing data therein;  
7 staging from the secondary storage to the primary storage data from the  
8 determined segment that is not in the partial version; and  
9 accessing the data from the determined segment staged from the secondary storage  
10 to the primary storage.

1 11. The method of claim 9, wherein the partial version is stored only for a  
2 first segment of the segments associated with the file.

1 12. The method of claim 6, further comprising:  
2 accessing data at the end of the segment, wherein the I/O request requires further  
3 file data after accessing the end of the segment;  
4 determining from the index a next segment including file data following the file  
5 data at the end of the segment data; and  
6 accessing the next segment in the primary storage to access the further required  
7 file data.

1 13. The method of claim 6, further comprising:  
2 maintaining metadata for each segment that is also maintained for files in the file  
3 system; and  
4 using the metadata for segments and files to determine when to copy segments  
5 and files to the secondary storage and when to release segments and files in the primary  
6 storage.

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1           14.     The method of claim 13, wherein segments and files in the primary storage  
2     are released according to their metadata if used space in the primary storage reaches a  
3     threshold level.

1           15.     The method of claim 6, wherein the file data in all the segments for the file  
2     is capable of being larger than a storage capacity of the primary storage.

1           16.     The method of claim 6, further comprising:  
2             reading data from one target segment on the secondary storage;  
3             determining whether a stage attribute is specified indicating a number of segments  
4     to stage ahead; and  
5             initiating read requests to stage the number of subsequent segments following the  
6     target segment from the secondary storage to the primary storage.

1           17.     The method of claim 16, further comprising:  
2             receiving user input indicating the number of segments to stage ahead.

1           18.     The method of claim 1, wherein the segment does not have a file name and  
2     is not represented as a file in the file system.

1           19.     The method of claim 1, wherein the index is stored in the file, wherein no  
2     user data is stored in the file and all the user data is distributed in the segments.

1           20.     A method for managing files in a primary and secondary storage, wherein  
2     the secondary storage is comprised of a plurality of drives and storage devices capable of  
3     being mounted on the drives, comprising:  
4             receiving data for a file;  
5             storing the data for the file in a plurality of segments;

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6 generating an index associated with the file indicating how file data maps to  
7 segments; and  
8 writing each segment to one of the drives, wherein segments are written to  
9 multiple of the drives to distribute the segments across multiple storage devices.

1 21. The method of claim 20, wherein multiple segments are written in parallel  
2 to multiple storage devices in multiple drives.

1 22. The method of claim 20, further comprising  
2 reading segments on multiple storage devices from multiple drives to stage  
3 multiple segments in parallel into the primary storage.

1 23. The method of claim 20, wherein the drives comprise tape drives and  
2 wherein the storage devices comprise tape cartridges.

1 24. A system for managing files, comprising:  
2 a computer readable medium;  
3 a storage system;  
4 means for receiving data for a file;  
5 means for storing the data for the file in a plurality of segments in the storage  
6 device;  
7 means for generating an index in the computer readable medium associated with  
8 the file indicating how the file data maps to the segments;  
9 means for receiving an Input/Output request with respect to an address in the file;  
10 means for using the index for the file to determine the segment including data at  
11 the requested address in the file; and  
12 means for accessing the determined segment including the data at the requested  
13 address.

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1        25.    The system of claim 24, wherein the means for storing the for the file in  
2 the segments performs:  
3        writing the received file data to one segment; and  
4        writing further received data for the file to subsequent segments if the last  
5 segment to which the received data was written has no more available space.

1        26.    The system of claim 24, wherein each segment has a fixed byte length,  
2 wherein the index provides a segment order indicating an order in which file data is  
3 written to the segments, and wherein means for using the index for the file to determine  
4 the segment including data at the requested address in the file performs:  
5        determining an offset into the file including the data at the requested address; and  
6        determining an integer quotient value resulting from the offset into the file divided  
7 by the fixed byte length, wherein the segment including the data at the requested address  
8 is the segment at the integer quotient value in the segment order.

1        27.    The system of claim 26, further comprising:  
2        means for receiving user input indicating the fixed byte length of each segment.

1        28.    The system of claim 24, further comprising:  
2        means for providing a segment size that is at least greater than a byte size of a  
3 largest section within the file; and  
4        means for writing each file section to one segment.

1        29.    The system of claim 24, wherein the storage system comprises a primary  
2 storage, further comprising:  
3        a secondary storage;  
4        means for copying at least one of the segments in the primary storage onto the  
5 secondary storage; and

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6 means for releasing at least one of the segments copied to the secondary storage,  
7 wherein space used by the released segment in the primary storage is available for use.

1 30. The system of claim 29, wherein as a result of releasing one or more  
2 segments, different segments for one file are capable of being stored in the primary  
3 storage and the secondary storage.

1 31. The system of claim 29, wherein the means for accessing the determined  
2 segment including the requested address further performs:  
3 determining whether the determined segment is available in the primary storage;  
4 and  
5 copying the determined segment from the secondary storage to the primary storage  
6 if the determined segment is not available in the primary storage.

1 32. The system of claim 29, wherein the means for releasing the segment  
2 performs:  
3 storing a partial version of the released segment including less than all data in the  
4 segment, wherein the segment data not in the partial version is stored in the secondary  
5 storage, wherein the partial version remains on the primary storage after the segment is  
6 released.

1 33. The system of claim 32, wherein the partial version of the determined  
2 segment is on the primary storage and wherein the means for accessing the determined  
3 segment including the requested address further performs:  
4 accessing the partial version of the determined segment on the primary storage to  
5 access the data therein;  
6 reaching the end of the partial version when accessing data therein;

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7 staging from the secondary storage to the primary storage data from the  
8 determined segment that is not in the partial version; and  
9 accessing the data from the determined segment staged from the secondary storage  
10 to the primary storage.

1 34. The system of claim 32, wherein the partial version is stored only for a  
2 first segment of the segments associated with the file.

1 35. The system of claim 29, further comprising:  
2 means for accessing data at the end of the segment, wherein the I/O request  
3 requires further file data after accessing the end of the segment;  
4 means for determining from the index a next segment including file data  
5 following the file data at the end of the segment data; and  
6 means for accessing the next segment in the primary storage to access the further  
7 required file data.

1 36. The system of claim 29, further comprising:  
2 means for maintaining metadata for each segment that is also maintained for files  
3 in the file system; and  
4 means for using the metadata for segments and files to determine when to copy  
5 segments and files to the secondary storage and when to release segments and files in the  
6 primary storage.

1 37. The system of claim 24, wherein segments and files in the primary storage  
2 are released according to their metadata if used space in the primary storage reaches a  
3 threshold level.

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1 38. The system of claim 29, wherein the file data in all the segments for the  
2 file is capable of being larger than a storage capacity of the primary storage.

1 39. The system of claim 29, further comprising:  
2 means for reading data from one target segment on the secondary storage;  
3 means for determining whether a stage attribute is specified indicating a number  
4 of segments to stage ahead; and  
5 means for initiating read requests to stage the number of subsequent segments  
6 following the target segment from the secondary storage to the primary storage.

1 40. The system of claim 39, further comprising:  
2 means for receiving user input indicating the number of segments to stage ahead.

1 41. The system of claim 24, wherein the segment does not have a file name  
2 and is not represented as a file in the file system.

1 42. The system of claim 24, wherein the index is stored in the file, wherein no  
2 user data is stored in the file and all the user data is distributed in the segments.

1 43. A system method for managing files, comprising:  
2 a primary storage;  
3 a secondary storage comprised of a plurality of drives and storage devices capable  
4 of being mounted on the drives;  
5 means for receiving data for a file;  
6 means for storing the data for the file in a plurality of segments on the primary  
7 storage;  
8 means for generating an index associated with the file indicating how file data  
9 maps to segments; and

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10 means for writing each segment to one of the drives, wherein segments are written  
11 to multiple of the drives to distribute the segments across multiple storage devices.

1 44. The system of claim 43, wherein multiple segments are written in parallel  
2 to multiple storage devices in multiple drives.

1 45. The system of claim 43, further comprising  
2 means for reading segments on multiple storage devices from multiple drives to  
3 stage multiple segments in parallel into the primary storage.

1 46. The system of claim 43, wherein the drives comprise tape drives and  
2 wherein the storage devices comprise tape cartridges.

1 47. An article of manufacture for managing files in a file system, comprising:  
2 receiving data for a file;  
3 storing the data for the file in a plurality of segments;  
4 generating an index associated with the file indicating how the file data maps to  
5 the segments;  
6 receiving an Input/Output request with respect to an address in the file;  
7 using the index for the file to determine the segment including data at the  
8 requested address in the file; and  
9 accessing the determined segment including the data at the requested address.

1 48. The article of manufacture of claim 47, wherein data is stored in the  
2 segments by:  
3 writing the received file data to one segment; and  
4 writing further received data for the file to subsequent segments if the last  
5 segment to which the received data was written has no more available space.

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1        49.    The article of manufacture of claim 47, wherein each segment has a fixed  
2    byte length, wherein the index provides a segment order indicating an order in which file  
3    data is written to the segments, and wherein the index for the file is used to determine the  
4    segment including data at the requested address in the file by:

5        determining an offset into the file including the data at the requested address; and

6        determining an integer quotient value resulting from the offset into the file divided  
7    by the fixed byte length, wherein the segment including the data at the requested address  
8    is the segment at the integer quotient value in the segment order.

1        50.    The article of manufacture of claim 49, further comprising:  
2        receiving user input indicating the fixed byte length of each segment.

1        51.    The article of manufacture of claim 47, further comprising:  
2        providing a segment size that is at least greater than a byte size of a largest section  
3    within the file; and  
4        writing each file section to one segment.

1        52.    The article of manufacture of claim 47, further comprising:  
2        storing the segments in a primary storage;  
3        copying at least one of the segments in the primary storage onto a secondary  
4    storage; and  
5        releasing at least one of the segments copied to the secondary storage, wherein  
6    space used by the released segment in the primary storage is available for use.

1        53.    The article of manufacture of claim 52, wherein as a result of releasing one  
2    or more segments, different segments for one file are capable of being stored in the  
3    primary storage and the secondary storage.

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1 54. The article of manufacture of claim 52, wherein accessing the determined  
2 segment including the requested address further comprises:  
3 determining whether the determined segment is available in the primary storage;  
4 and  
5 copying the determined segment from the secondary storage to the primary storage  
6 if the determined segment is not available in the primary storage.

1 55. The article of manufacture of claim 52, wherein releasing the segment  
2 comprises:  
3 storing a partial version of the released segment including less than all data in the  
4 segment, wherein the segment data not in the partial version is stored in the secondary  
5 storage, wherein the partial version remains on the primary storage after the segment is  
6 released.

1 56. The article of manufacture of claim 55, wherein the partial version of the  
2 determined segment is on the primary storage and wherein accessing the determined  
3 segment including the requested address further comprises:  
4 accessing the partial version of the determined segment on the primary storage to  
5 access the data therein;  
6 reaching the end of the partial version when accessing data therein;  
7 staging from the secondary storage to the primary storage data from the  
8 determined segment that is not in the partial version; and  
9 accessing the data from the determined segment staged from the secondary storage  
10 to the primary storage.

1 57. The article of manufacture of claim 55, wherein the partial version is  
2 stored only for a first segment of the segments associated with the file.

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62. The article of manufacture of claim 52, further comprising:  
reading data from one target segment on the secondary storage;  
determining whether a stage attribute is specified indicating a number of segments  
to stage ahead; and

5 initiating read requests to stage the number of subsequent segments following the  
6 target segment from the secondary storage to the primary storage.

1 63. The article of manufacture of claim 62, further comprising:  
2 receiving user input indicating the number of segments to stage ahead.

1 64. The article of manufacture of claim 47, wherein the segment does not have  
2 a file name and is not represented as a file in the file system.

1 65. The article of manufacture of claim 47, wherein the index is stored in the  
2 file, wherein no user data is stored in the file and all the user data is distributed in the  
3 segments.

1 66. An article of manufacture for managing files in a primary and secondary  
2 storage, wherein the secondary storage is comprised of a plurality of drives and storage  
3 devices capable of being mounted on the drives, by:  
4 receiving data for a file;  
5 storing the data for the file in a plurality of segments;  
6 generating an index associated with the file indicating how file data maps to  
7 segments; and  
8 writing each segment to one of the drives, wherein segments are written to  
9 multiple of the drives to distribute the segments across multiple storage devices.

1 67. The article of manufacture of claim 66, wherein multiple segments are  
2 written in parallel to multiple storage devices in multiple drives.

1 68. The article of manufacture of claim 66, further comprising

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2 reading segments on multiple storage devices from multiple drives to stage  
3 multiple segments in parallel into the primary storage.

1 69. The article of manufacture of claim 66, wherein the drives comprise tape  
2 drives and wherein the storage devices comprise tape cartridges.

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